

# **Unmanned Aerial Systems Traffic Management (UTM)**

## **Technology Capability Level Field Demonstrations**

NASA

<http://www.utm.arc.nasa.gov>

Moffett Field, CA

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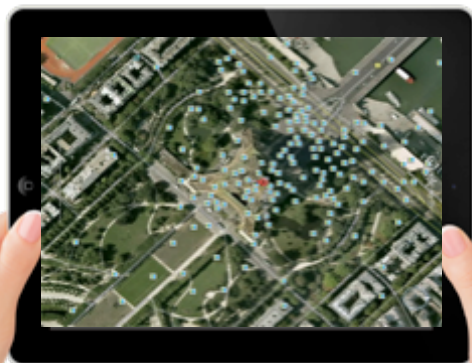
Operational Rules and  
Guidelines

UAS Requirements

CNS Requirements

Airspace Management Requirements

Data Services, Interfaces, and Architecture  
Requirements



Field Demonstration Objectives

## TCL 1: August 2015

Line of Sight Operations

Low Risk Environment

Airspace Reservation

Geo-fencing for Separation

No Fly Zones

User Authentication

## TCL 2: October 2016

Beyond Line of Sight Operations

Low Risk Environment

Segmented Flight Plans

Weather and Traffic Advisories

Altitude Stratification

Contingency Management (Alerting)

System Health Monitoring





# TCL 1 UAS Operations

## Manufacturing

EM Tower Inspection  
Wind Turbine Inspection  
Bridge Inspection  
Power Line Inspection  
Solar Panel Inspection  
Rail Inspection  
Landfill Inspection  
Pipeline Inspection  
Dam Inspection  
Canal Inspection

## Farming

Aerial Application  
Precision Agriculture  
Livestock Monitoring  
Invasive Plant Monitoring

## Other

Forest Management  
Mosquito Monitoring  
Wildlife Conservation  
Archaeology  
Anthropology  
Prospecting

## Oceanic

Maritime Surveillance  
Maritime Scouting  
Ocean Research  
Anti-Piracy

## Recreation

Animal Spotting for Hunting  
Nature Photography  
Adventure Sports Photography

## Typical Operation Limitations

Line of Sight Operations

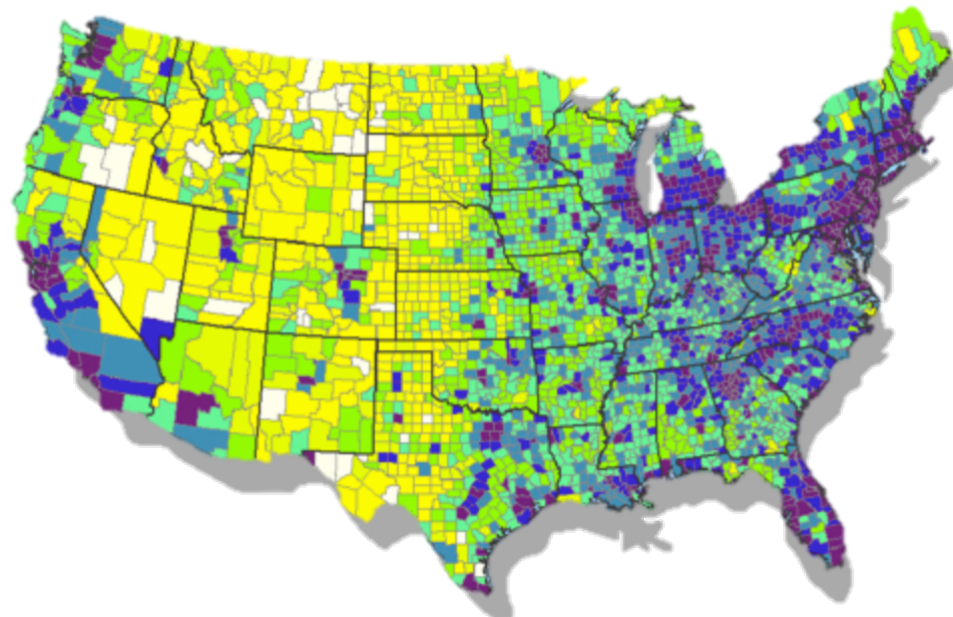
Sparsely Populated Areas

Typically <400 ft AGL

VMC Conditions & Daylight

UAS < 55lbs

500 ft away from structures



# *TCL 1 Demonstration Overview*





**Airware ne<sup>3</sup>rd**

**PRECISIONHAWK**



**UNMANNED  
EXPERTS**



**SKY SPECS**

**LONE STAR UAS**



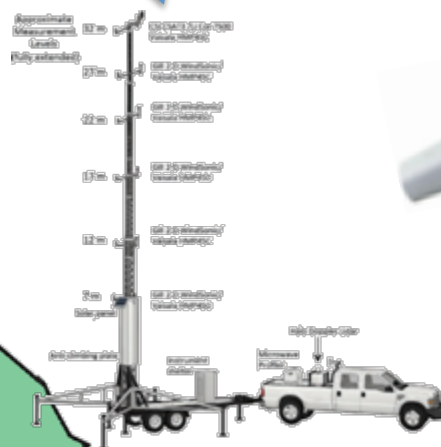
CENTER OF EXCELLENCE & INNOVATION

## Simultaneous UAS Operations

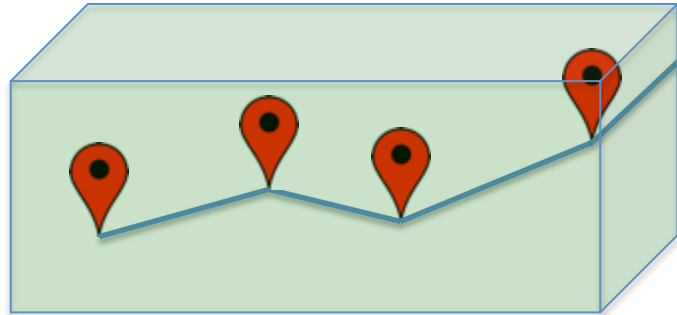


Aug. 24 – Sept 1<sup>st</sup>, 2015  
~ 108 Flights  
~18 Flight Hours  
Duration: 2-38 minutes  
Avg. Flight Time: ~ 11 min

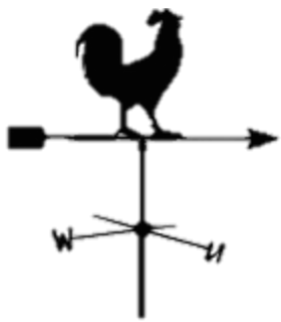
*Crows Landing, CA*



# Demonstration Objectives



**Objective 2:** Collect Data on UAS Navigation Performance Error



**Objective 4:** Collect Weather Observations for Forecasting Models



**Objective 1:** Demonstrate UTM Capabilities

**Objective 5:** Collect Data on Noise Signature of UAS Vehicles

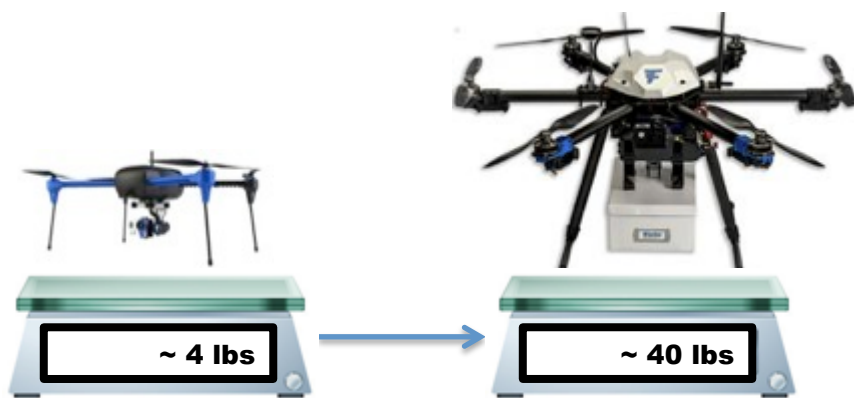


**Objective 3:** Collect Data on Aircraft Tracking Performance

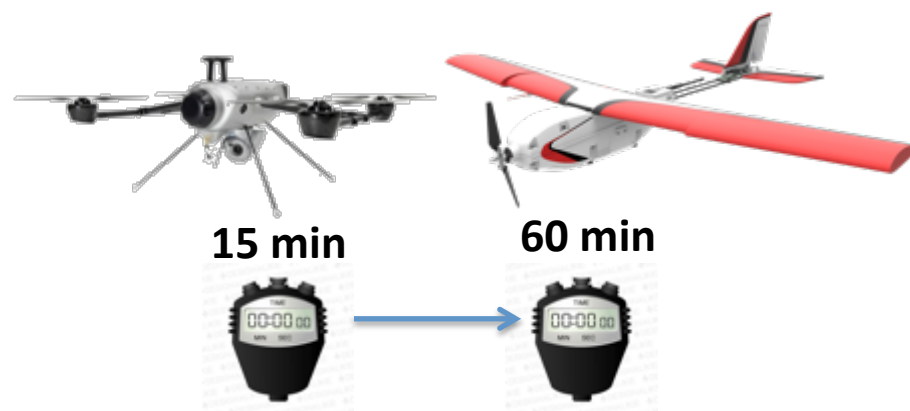


# UTM Vehicles

8 multi-rotors and 2 fixed wing



**Maximum Take-off Weight**



**Endurance**



# UTM Manager Displays



**Java-based Desktop Display**



**iOS Application**

# UTM Field Equipment : Weather

**32m Weather Tower**



**Radiosonde  
Weather Balloon**

**Data Collected**

**Temperature  
Pressure  
Wind Direction  
Wind Speed  
Altitude  
Turbulent Kinetic Energy**

**Remote Automated Weather Station**



# UTM Field Equipment : Surveillance and Acoustics

## Short Range Radar



## Cellular Network Tracking



## ADS-B Out Transponder

## Data Collected

**Latitude**  
**Longitude**  
**Altitude**  
**Sound magnitude and frequency**

## Acoustic Measurement

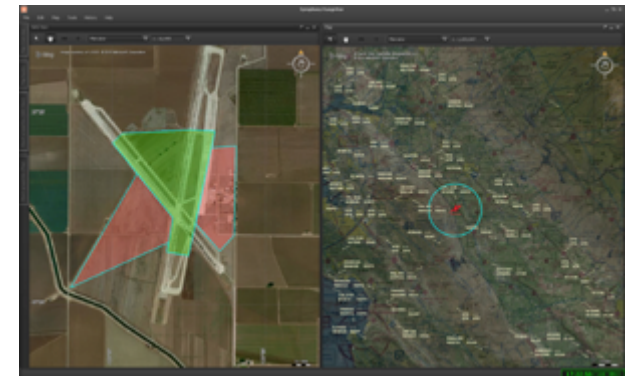
Nicolet Vision XP



B&K Nexus  
4-Ch Power Supply



1/2" B&K  
Microphone  
+ Wind Screen



**Ground Situation Awareness  
Display (ADS-B In, En Route  
radar, Terminal Radar, ASDE-  
X, ASSC)**

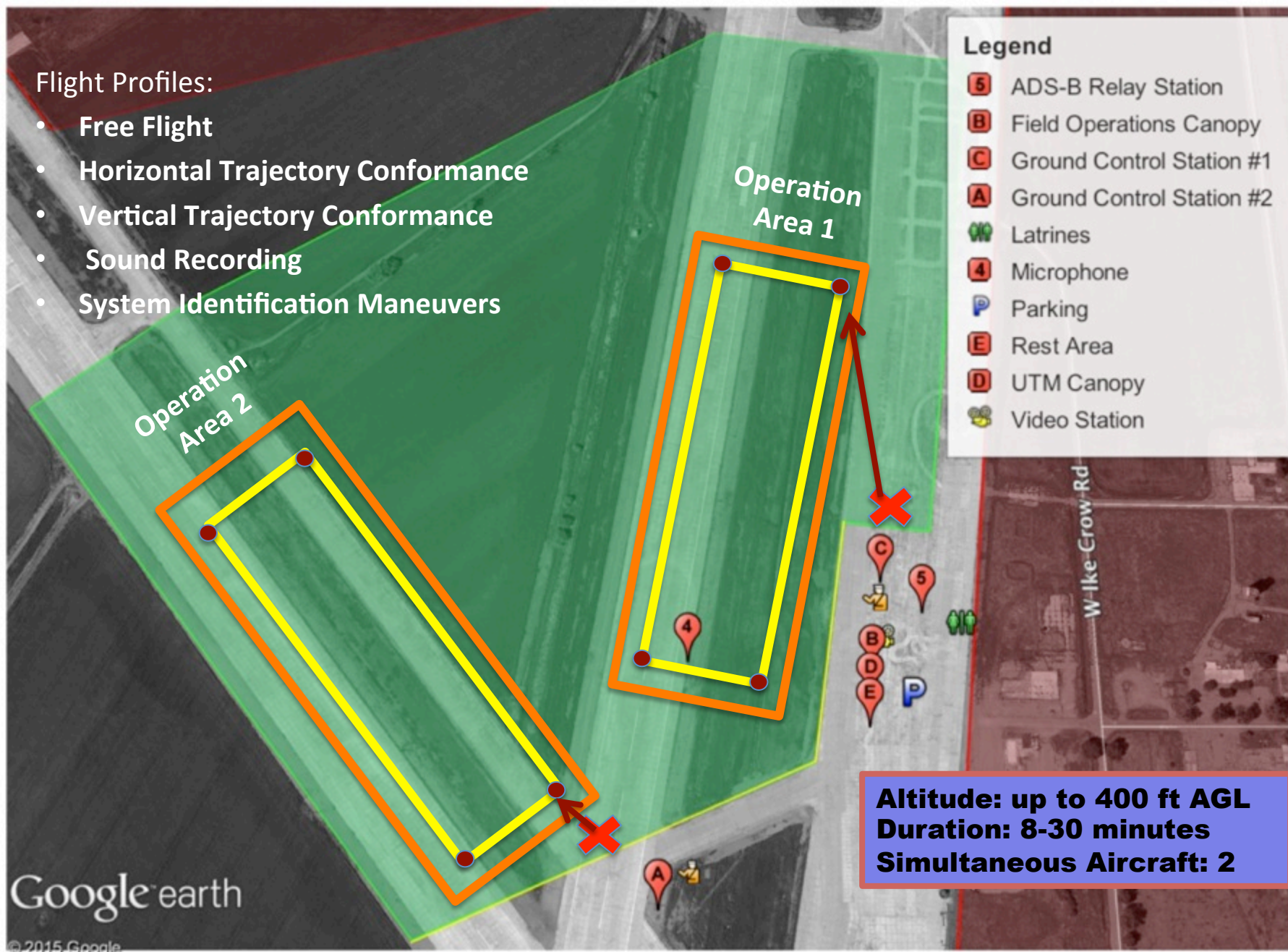


### Flight Profiles:

- Free Flight
- Horizontal Trajectory Conformance
- Vertical Trajectory Conformance
- Sound Recording
- System Identification Maneuvers

### Legend

- 5** ADS-B Relay Station
- B** Field Operations Canopy
- C** Ground Control Station #1
- A** Ground Control Station #2
- Latrines
- 4** Microphone
- P** Parking
- E** Rest Area
- D** UTM Canopy
- Video Station



# Observations of Operational Use

- *New Airspace Users will require training and UTM needs to be intuitive*
  - **Observation:** UAS Operators submitting an operational plan to the system that differs from what was input into the GCS or a willingness to violate an operational plan.
  - **Recommendation:** Operator training and integration of flight planning and traffic management services into ground control stations
- *The right equipment for the operational environment*
  - **Observation:** High temperatures had impact on ground equipment. C2 interference occurred with local farming equipment. Degradation of GPS signals impacted flight operations.
  - **Recommendation:** UAS and ground systems and instruments are “qualified” by operational environment and performance.
- *Situation awareness is key for safe operations*
  - **Observation:** sUAS varies with size and line of sight (LOS) can be easily lost (e.g. sUAS looked like birds during operation). Weather reported on the ground isn't always indicative of weather experienced at operational altitude. Tracking of sUAS needs to occur at sufficiently fast update rates.
  - **Recommendation:** Improvements are needed in weather forecasting, modeling, and sensing at low altitudes. Tracking UAS infrastructure will need to be built to scale and with sufficient bandwidth. Airspace users should be given a common picture of their environment for safe operations.

# *Next Steps: TCL 2 Demonstration*



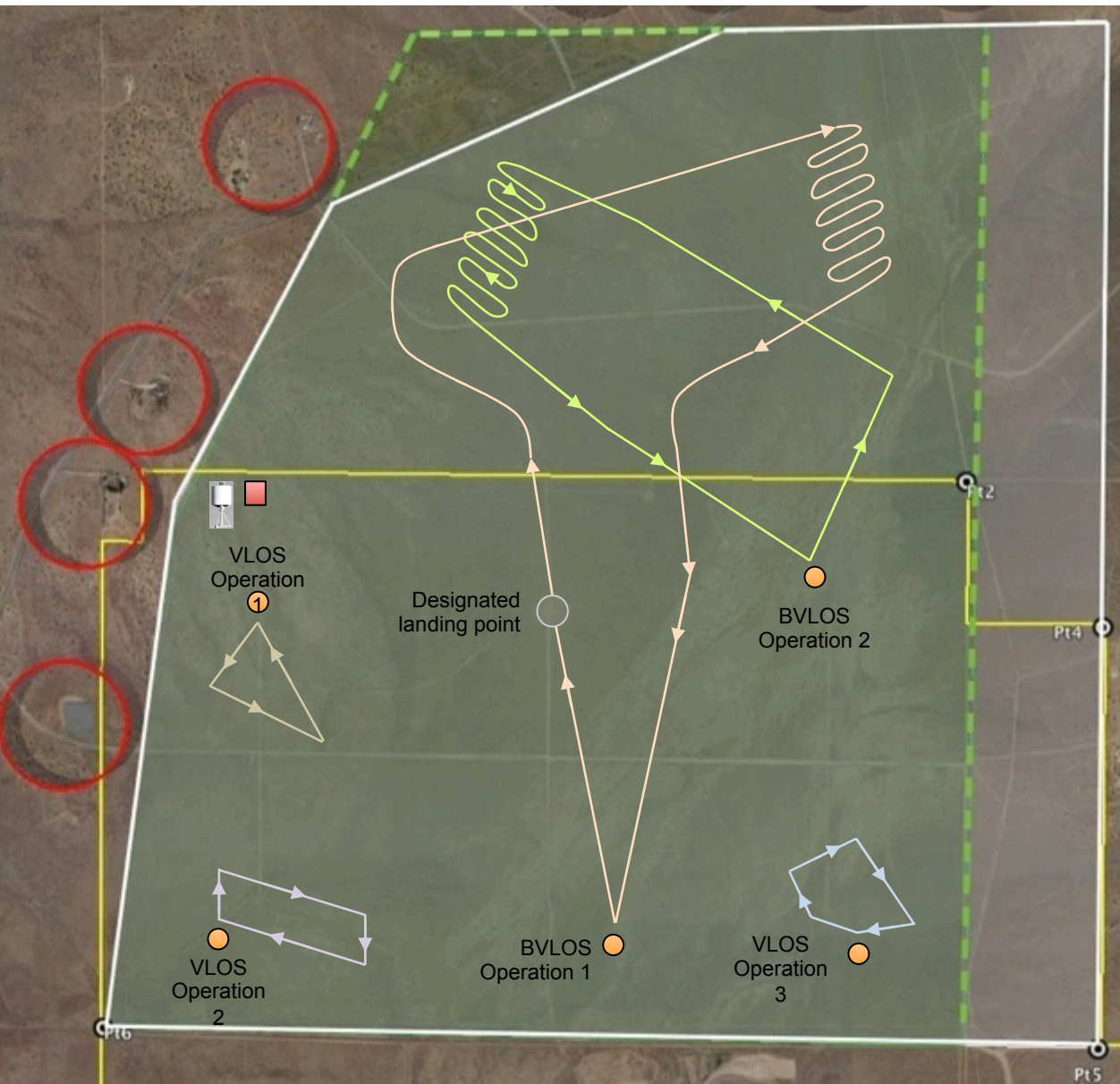




# TCL 2 Demonstration Characteristics

- Flight Operations:
  - Operate 5 simultaneous operations
  - Operate two aircraft beyond visual line of sight (BVLOS)
  - Operate two aircraft in an altitude separated operation in visual line of sight (VLOS)
  - Operate two aircraft in an altitude-separated operation in BVLOS
  - Demonstrate Live-Virtual-Constructive Operations
- UTM Functionality:
  - Alerting UAS operators of threat aircraft based on data from surveillance system
  - Monitoring UAS operations for flight plan conformance
  - Alerting UAS Operators due to weather disruption
  - Alerting and contingency management procedures initiated by ***simulated*** in-flight emergencies of UAS operations
  - Dynamic requested flight plan rerouting
  - Public safety operations

# TCL 2 Demonstration: Reno-Stead Airport



**Dates: Oct. 17<sup>th</sup> -26<sup>th</sup>**

## Reno-Stead Airport:

- Part of UAS Test Site
- Public and military general aviation airport located 10 nautical miles northwest of Reno, Nevada.
- Location of the Reno Air Races
- Elevation: 5050 ft (AMSL)

## 14+ Partners:

- BVLOS Vehicles
- Surveillance and Weather Equipment



*Questions?*